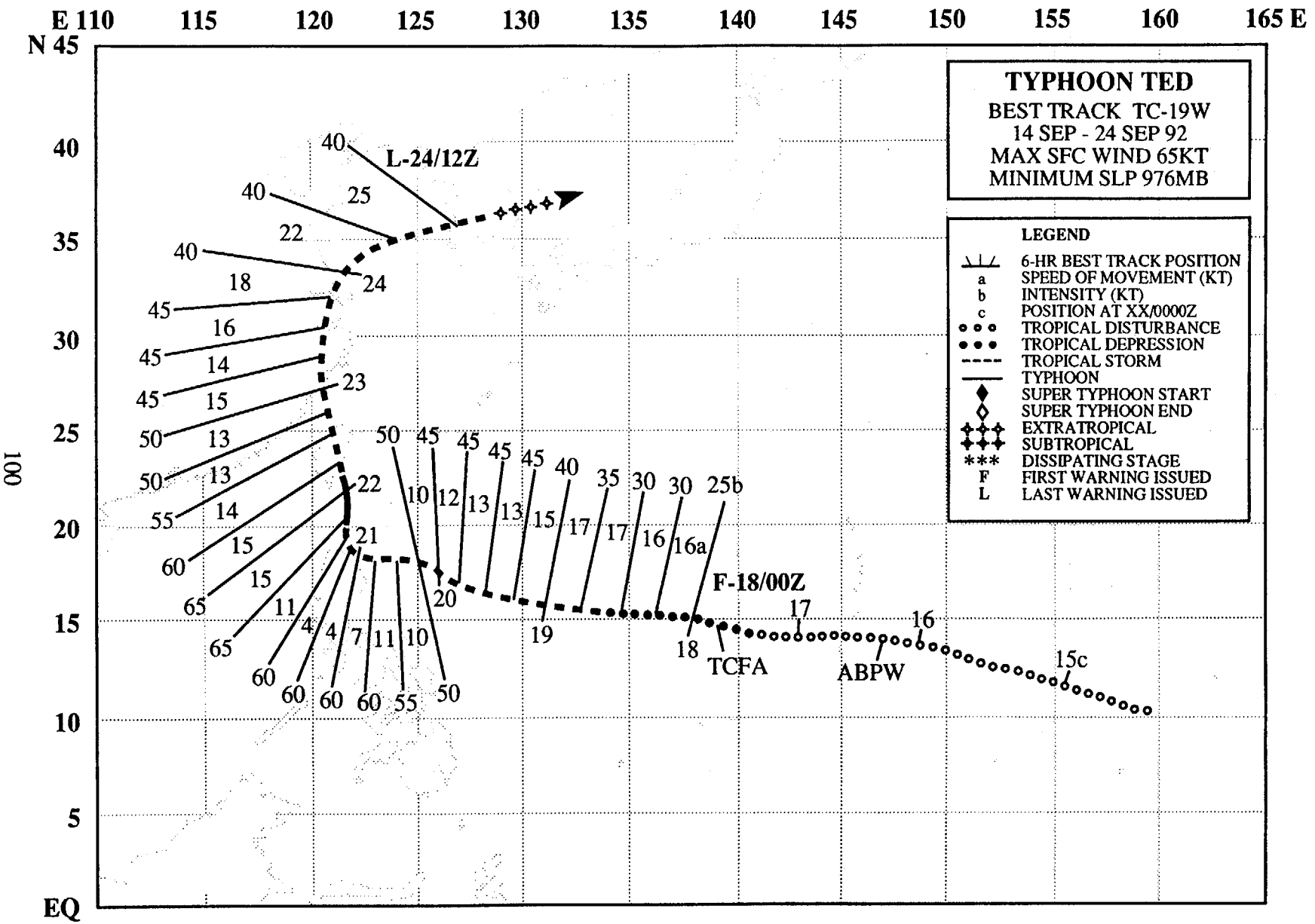
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TYPHOON TED
BEST TRACK TC-19W
14 SEP - 24 SEP 92
MAX SFC WIND 65KT
MINIMUM SLP 976MB
LEGEND
6-HR BEST TRACK POSITION
a SPEED OF MOVEMENT (KT)
b INTENSITY (KT)
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED
L-24/12Z
F-18/00Z
TCFA
ABPW

TYPHOON TED (19W)

I. HIGHLIGHTS

As Typhoon Sibyl (18W) transitioned to an extratropical system and proceeded northeastward, a weak monsoon trough was becoming established to the north of the Caroline Island chain. A few days of respite ensued for JTWC while the disturbance that was to become Typhoon Ted slowly developed. Ted was marked by moderate to strong upper-level shear throughout most of its life, creating a cloud pattern which obscured the low-level circulation center rather frequently. A combination of shearing effects and land interaction prevented Ted from intensifying above minimal typhoon. Ted's tour of Asia included northern Luzon, northeastern Taiwan, eastern China, and finally Korea before the circulation transitioned to a weak extratropical cyclone over the Sea of Japan.

II. TRACK and INTENSITY

On the 13 September Significant Tropical Weather Advisory, forecasters first noted the monsoon trough which would produce the circulation of Typhoon Ted. But, it was not until 16 September that a circulation became apparent. By 17 September, a TUTT-cell had become positioned to the northwest of the disturbance, enhancing its outflow, and organization began to significantly improve. A Tropical Cyclone Formation Alert was issued at 172030Z in response to an increase in convective curvature and a flare-up of convection coincidental with the convectional diurnal maximum. In retrospect, the alert was about 18 hours behind the power curve. The first warning was issued by JTWC at 180000Z, and the depression initially proceeded west-northwestward. But, at 180600Z, the mid-level subtropical ridge became stronger and the system accelerated on a more westward course. Convective banding and organization continued to improve, and the system was upgraded to tropical storm intensity at 181800Z. Shortly thereafter, the first indication of significant shear over Ted was observed as the low-level circulation was consistently located under the eastern portion of the deepest convection (Figure 3-19-1). Between 191800Z and 201200Z, Ted slowed, and proceeded generally northwestward as a deepening low pressure system near Hokkaido, Japan temporarily weakened the low- to mid-level subtropical ridge. Ted resumed its westward track, and continued to slow as the system approached the westernmost extent of the ridge. At the surface, a high pressure system was building behind the low pressure system over Hokkaido and this wave pattern proceeded eastward rapidly. By 210000Z, all of the pieces were in place for Ted to proceed northward: 1) satellite imagery revealed a coupling between outflow from Ted and the mid-latitude frontal system; 2) as the high pressure system to the north of Ted moved eastward, pressures immediately north of Ted were falling; and, 3) synoptic data revealed that a weakness in the mid-level subtropical ridge became situated to the north of Taiwan. The reduced upper-level winds Ted encountered in the vicinity of the Luzon Strait enabled the system to briefly attain typhoon intensity (Figure 3-19-2), but at 220600Z, land interaction and increased upper-level wind flow caused Ted to revert back to tropical storm status where it remained until transformation to an extratropical low several days later. Ted accelerated during its northward transit until reaching 25 kt (46 km/hr) after recurvature. At 241200, Ted became extratropical and JTWC issued the final warning on the system.

III. FORECAST PERFORMANCE

Systems which are consistently difficult to accurately locate generally produce the largest track forecast errors, and Ted was no exception. The initial acceleration of Ted south of the subtropical ridge was not forecast, but the acceleration was a relatively short-term phenomenon and did not severely

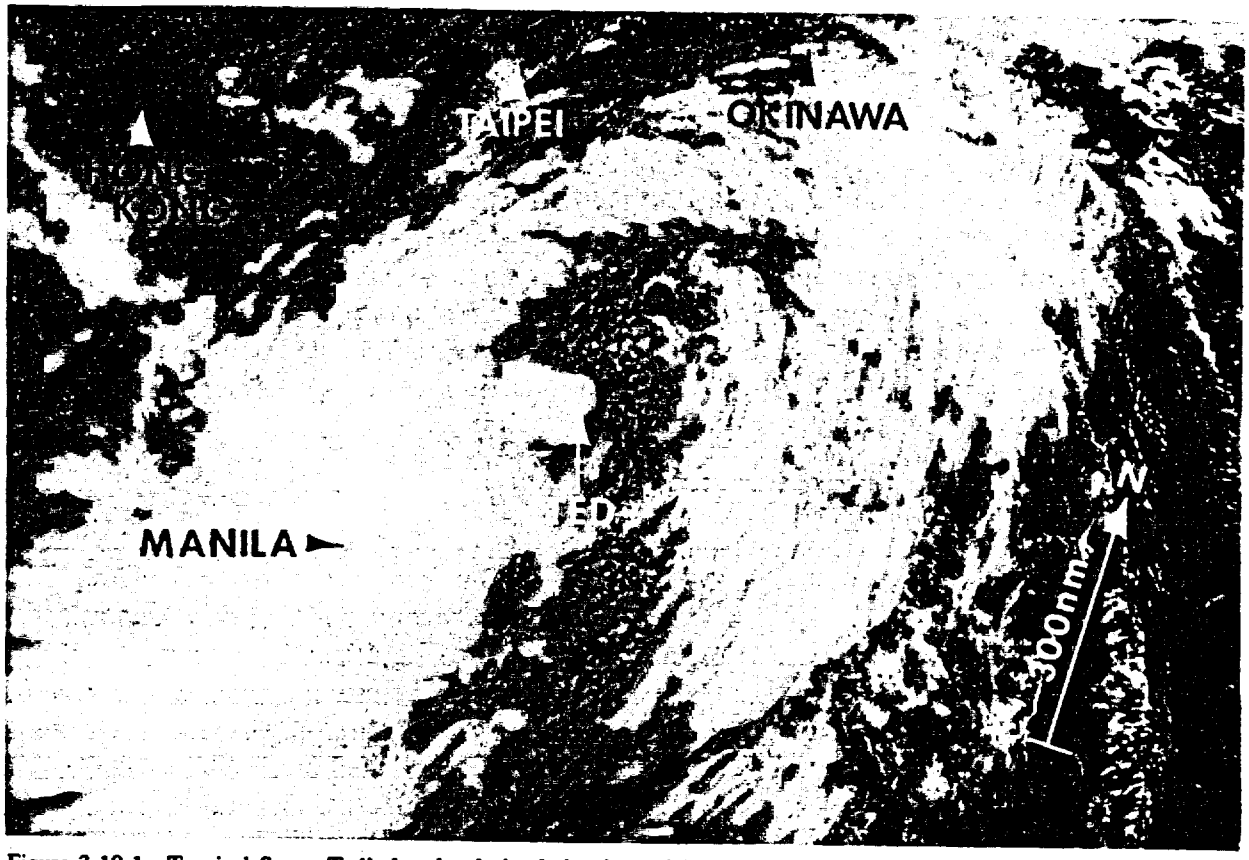

Figure 3-19-1. Tropical Storm Ted's low-level circulation is partially exposed as it approaches northern Luzon (200637Z September NOAA visual imagery).

impact the longer range forecast errors. JTWC forecasters lost faith in the NOGAPS numerical model early on as the model predicted slow northwestward to northward motion at the time Ted was transiting rapidly westward. As a result, forecasters relied heavily on persistence-and-climatological-based aids. After Ted turned north near Luzon, NOGAPS performed well, accurately predicting wave patterns in the mid-latitudes and the breakdown of the mid-level subtropical ridge near Taiwan. The premature lifting of a tropical cyclone to the north through a break in the subtropical ridge is typical of the NOGAPS or any model in general due to the coarse resolution. Once Ted entered the Luzon Strait, NOGAPS locked on to Ted's track (Figure 3-19-3). Tropical Storm Wendy in 1974 exhibited remarkably similar track characteristics, and was initially used by forecasters as an analog. It was recognized as an analog by forecasters only after northward movement in the Luzon Strait became apparent. The following forecast weaknesses were noted:

1) Over reliance on persistence and inadequate interpretation of flow patterns observed in satellite imagery and predicted by numerical models. For example: once Ted slowed to 4 kt (7 km/hr) in the Luzon Strait, forecasters hesitated in showing northward acceleration. The weakness in the subtropical ridge to the north was suggested by the linkage of convection between Ted and the mid-latitude frontal boundary on satellite images. Only when the speed had apparently increased to above 10 kt (19 km/hr), did JTWC forecasts indicated significant acceleration.

2) Failure to modify longer range intensity forecasts once it became apparent that upper-level shear would increase and remain persistent, and land interaction became inevitable. Some of the difficulty in this area could be attributed to the uncertainty in initial position of Ted at the various warning times, which inaccurately reflected the true motion over the previous 6- to 12-hour period.

IV. IMPACT

On northern Luzon, torrential rains from Ted caused landslides and flooding which resulted in at least 8 fatalities. The impact on Taiwan and eastern China was similar with heavy rains, flooding and landslides. However, the losses were much greater in eastern China where at least 53 lives were lost and as many people were reported as missing; over 30,000 houses collapsed; and extensive damage to agricultural land occurred. No loss of life or significant damage reports were received from Korea.

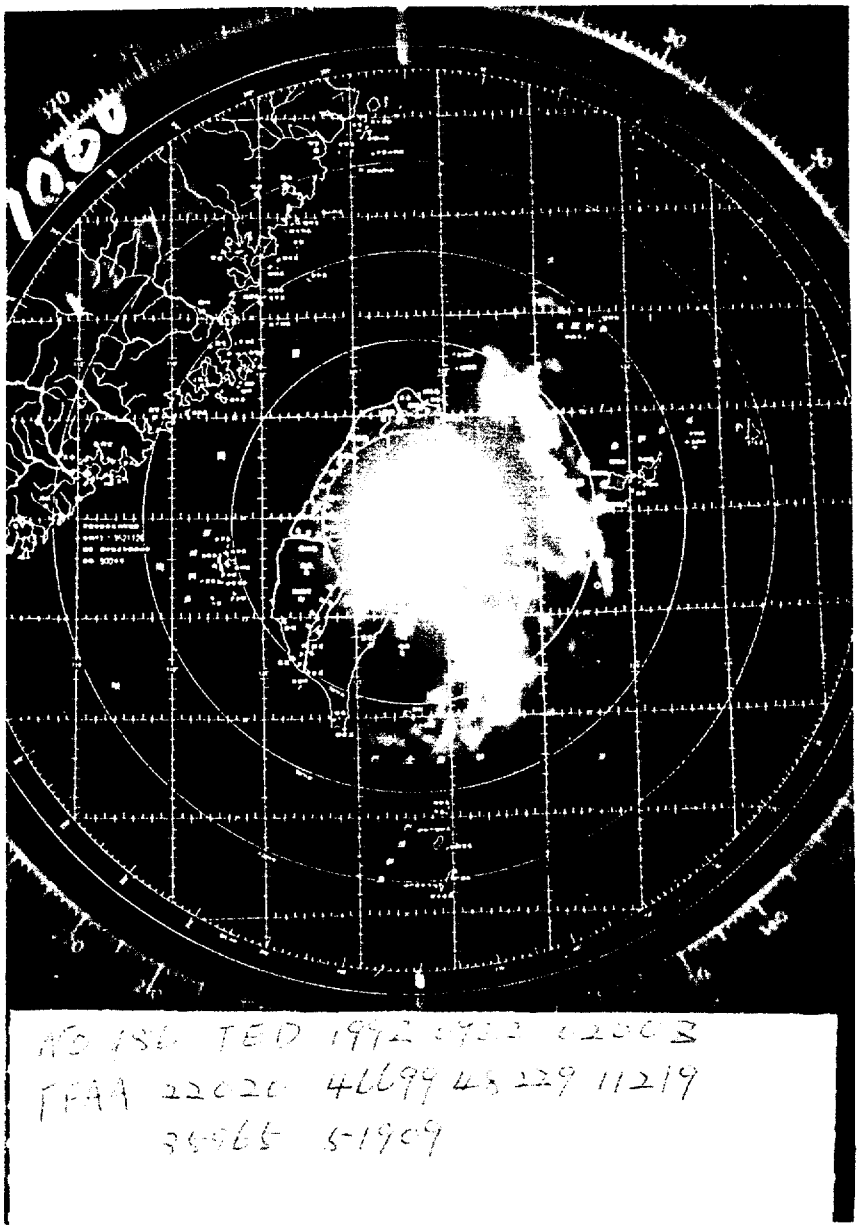

Figure 3-19-2. The 220200Z September radar image from Haulien (WMO 46699) of Ted at peak intensity (radar photo courtesy of the Central Weather Burea, Taipei, Taiwan).

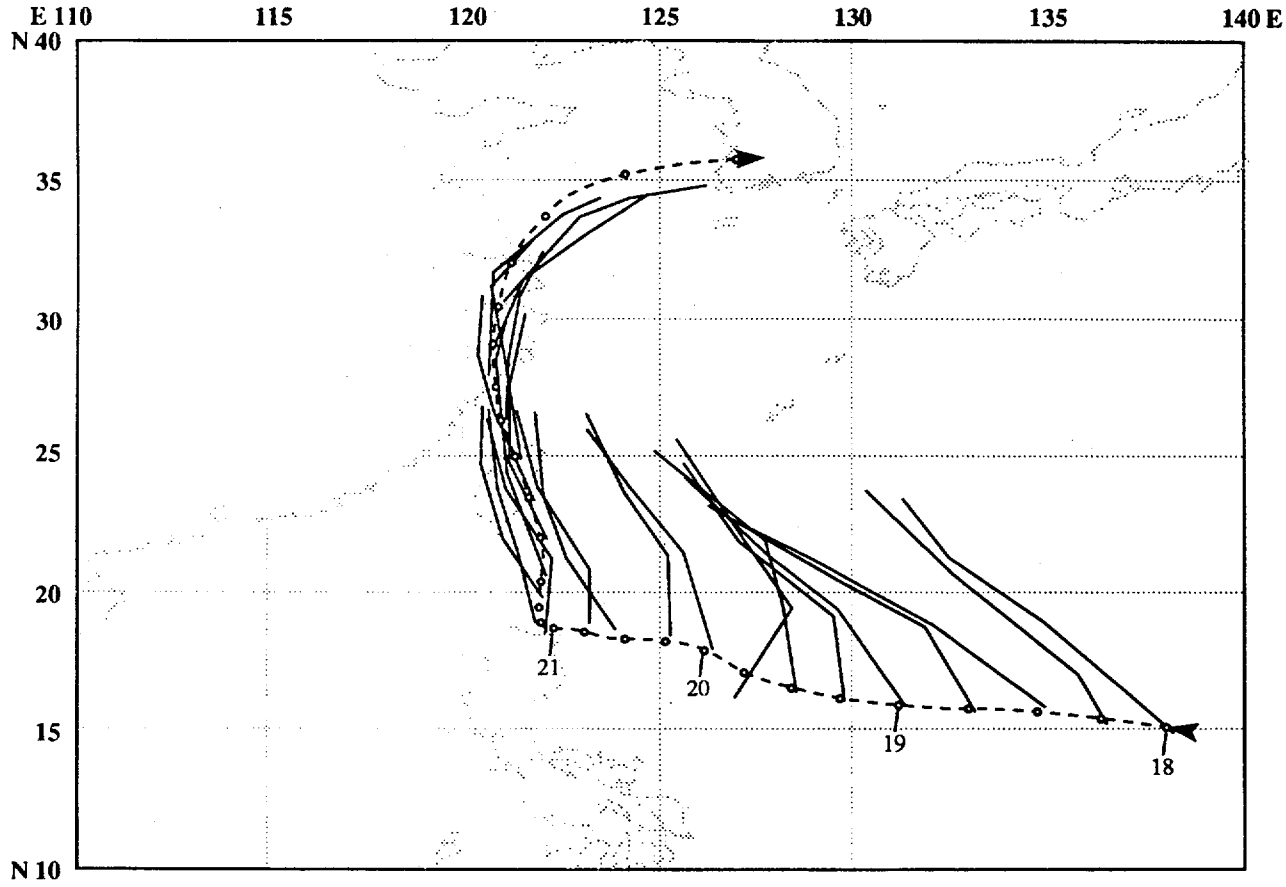

Figure 3-19-3. NOGAPS guidance for Ted is consistently north of track until the tropical storm enters the Luzon Strait, then the model locks on.